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Low-Resolution Fluorescence Analyzer

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Beamline(s): X21

Introduction: X-ray absorption spectroscopy suffers quite often from the overlap of different edges in one compound. The typical solution is to use an energy-dispersive detector to measure the fluorescence of the element under investigation. This method works only as long as the difference of the energies of the fluorescence lines is much larger than the energy resolution of the detector. If the difference is smaller, analyzer crystals have to be used to separate the different fluorescence lines and suppress the unwanted elements.

Methods and Materials: We used a cylindrically bent Si(004) crystal and an NaI(Tl) detector with sample, analyzer and detector on Rowland circle. The analyzer crystal had an effective area of 90mm x 115mm, and a bending radius of 1m. The sample was a mixture of $LiMnO_4$ and $Eu_3Fe_5O_{12}$. The Mn K α_1 fluorescence at 5898eV is very close to the Eu Lα_1 fluorescence at 5846eV. These two fluorescence lines cannot be separated by conventional energy dispersive detectors.

Results: We measured the Mn K and Eu L_{III}-edges of the mixture with the spectrometer and with a conventional Amptek Si PIN-detector. The experimental results are shown in the figure, the data taken with the spectrometer are in black, the ones of the Amptek detector are shown in blue. The Amptek detector clearly sees the Eu fluorescence photons which are emitted as the incident energy is tuned to the Eu L_{III}-edge at 6977eV, which are suppressed by the spectrometer. The higher absorption by the sample, however, causes a small dip in intensity at the same energy. Since we detected only Mn Kα_1 fluorescence photons, some lifetime effects in the near-edge region can be observed.

Conclusions: This spectrometer is useful for some applications in research. The disadvantages are still a low count-rate and the and the limited size of the detector. Based on the experience of this experiment, a new version of the spectrometer with a smaller bending radius of the crystal and a position-sensitive detector are planned for next year.

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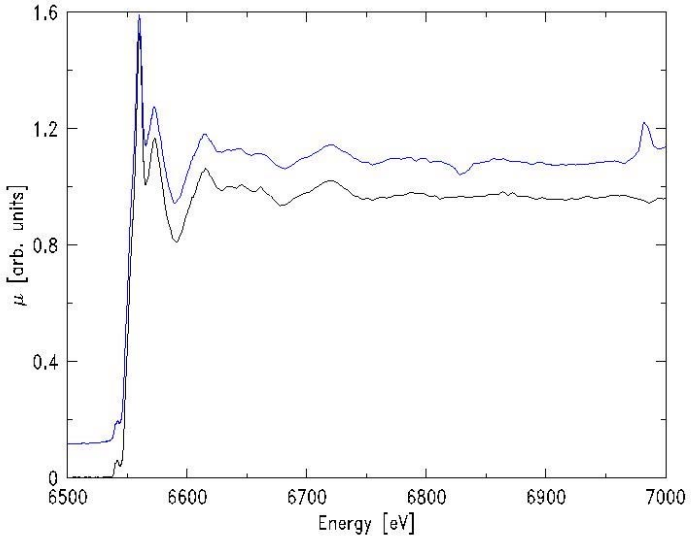

Mn K-edge of LiMnO4 in a mixture of LiMnO4 and Eu3Fe5O12. The edge is measured with a fluorescence spectrometer (black) and a Si PIN-detector (blue).